Identification of Methane Hazards Near Municipal Landfills
Two Australian Case Studies

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INTRODUCTION

- Sydney, NSW (within Australia’s most populated state) there is increasing pressure for urban land
- Land that was once on the fringes of urban areas is now sought after as prime residential land
- In some cases residents of new developments are now neighbours with old municipal landfills
- Identifying methane hazards is important in the landfill rehabilitation and land redevelopment process
METHANE

- Colourless, odourless, tasteless gas
- Sources include swamps, coal/oil mining, fermentation and landfills
- Methane (CH₄) is flammable and has a Lower explosive limit of 5% (v/v)
- Methane can cause oxygen deficient environments (asphyxiation) and explosion risks
- Methane produced in landfills can present a hazard to neighbouring areas
CASE STUDIES - OUTLINE

- Two Australian landfill sites north of Sydney where methane investigations were carried out as part of rehabilitation planning
- Both sites were adjacent to new residential subdivisions
- Results of the studies are presented including investigation techniques used to identify the presence of methane, potential sources, pathways and remedial management options
CASE STUDY 1

- Methane Investigation requested as part of landfill rehabilitation planning process
- Explosive concentrations of methane identified near adjacent residential subdivision

Objectives

- Assess nature and extent of methane
- Identify the sources of methane and migration pathways
- Provide advice on short term remediation
- Monitoring
- Risk Analysis
**SITE LAYOUT**

- Residential Subdivision
- Former Landfill (North)
- Former Landfill (South)
- Oval & Car Park (former sanitary depot)
- Wetland

- Main Drainage Lines
- Sewers

Dimensions:
- 300m
- 180m
POTENTIAL METHANE SOURCES

“LANDFILL”

- Fill Soils
  - Sanitary waste depot
  - Subdivision fill
  - Backfill around sewers and underground service trenches

- Natural organic soils
- Leaks in natural gas pipelines
- Deep coal seams
POTENTIAL METHANE MIGRATION PATHWAYS?

- Migration of Methane Through the Vadose Zone When Water Table is Low
- Migration of Methane Through Services Trenches or Disused Conduits
- Migration of Dissolved Methane in Groundwater
INVESTIGATIONS, SHORT TERM REMEDIATION AND MONITORING

- Construction of gas venting trench
- Monitoring inside residential houses
- Site history study and literature review
- Geophysical surveys
- Insitu soil gas testing (724 locations)
- Logging of Test Pits and Boreholes (44 locations)
- Installation and sampling of gas and groundwater wells (66 locations)
- Gas analysis (fingerprinting)
- Groundwater Analysis (dissolved methane)
- Soil Analysis (total organic carbon)
- Gas pressure testing
Former Landfill (North)

GAS VENTING TRENCH
INSTALLATION OF GAS VENTING TRENCH

Perforated Pipe

Gravel Filled Trench

Clay Cap

Ventilator

Perforated Pipe
TYPICAL GAS WELL

- Slotted Pipe
- Gravel Pack
- Concrete and Bentonite Seals
- CH₄ Meter

CH₄

Gravel Pack

Slotted Pipe

CH₄

CH₄
STAGED GAS MONITORING
WELLS

Monitoring wells screened to target different soil units

Unit 1

Unit 2

Unit 3
MONITORING FROM GAS WELL
GEOLOGICAL MODEL

- Residual clay grading to Patonga claystone
- LANDFILL
- Vent Structure
- Drain
- High methane readings
- Channel Alluvium
- Floodplain Alluvium
- SURDIVISION FILL
- Dune Sand
- Residual clay grading to Patonga claystone
RESULTS
SUBSURFACE METHANE CONCENTRATIONS

Methane levels up to 60% in landfill and subdivision

One property recorded 30% methane in a void beneath the concrete slab
RESULTS
SUBSURFACE METHANE CONCENTRATIONS

Typically, areas that did not have fill recorded low methane concentrations.
IS THE LANDFILL THE SOURCE OF METHANE FOUND IN THE SUBDIVISION?

- Migration through vadose zone (unlikely)
  - discontinuities in high methane concentrations
  - the north-south drain
  - relatively high water table
  - Fingerprinting - no correlation between gas in landfill and gas in subdivision
- Migration Through Service Trenches (unlikely)
  - similar issues
- Migration Through Groundwater (unlikely)
  - Low solubility
  - Concentrations encountered too high for dissolved methane
  - Low pressures
- Landfill encroaching into subdivision (unlikely)
  - Site history and aerial photographs do not show landfill encroaching into the subdivision
IS METHANE IN THE SUBDIVISION DERIVED FROM FILL OR NATURAL ORGANIC SOILS?

- Anecdotal information suggests burial of vegetation and organic soils in the subdivision.
- Vegetation observed in test pits and Total organic carbon results indicated that the fill and floodplain alluvium have organics (2%-4%).
- Conditions beneath the subdivision may be suitable for production of methane.
- Soccer Oval (Control site) 1.5km away from the landfill in a similar environment shows similar trend with CH$_4$ levels up to 20%.
CONTROL SITE

Soccer Oval (Control Site)

Landfill

~1.5km
WHAT TO BE AWARE OF?

- No guidance in Australia on naturally produced methane
- Soils which could naturally generate methane
- Low lying or filled areas
- Similar site settings
HOW CAN THIS PROBLEM BE MANAGED?

- Through the planning process
- Guidance by regulatory agencies
- Being aware of the problem
- Preliminary testing for methane on sites at risk
- Methane generating capacity testing
- Risks Assessment

In this case the site was managed through regulatory control, notation on the land planning certificate and notification to land owners.
CASE STUDY 2

- Methane Investigation requested as part of landfill rehabilitation planning process
- Relatively new residential subdivision (1999) located near landfill
- Investigations concentrated along boundary of landfill adjacent to the subdivision
- Study objective were to assess the potential for methane migration from the landfill towards the subdivision
INVESTIGATION TECHNIQUES

- Site history Study
  - Aerial photographs
  - Interviews
  - Old site plans
  - Council records
- Geophysical (electromagnetic survey)
- Installation and monitoring from gas wells
Landfill (former quarry)

Residential Subdivision (former quarry)

Sandstone Pillar

1999
Potential Area of Concern

1984
ELECTROMAGNETIC PROFILE RESULTS

0 to 5m

5m to 10m

10m to 15m
GAS WELL LOCATIONS

Landfill

Residential Subdivision

Gas Well
RESULTS

CH₄ < 0% (v/v)

CH₄ up to 44% (v/v)

CH₄ < 0% (v/v)

Waste encroaches into residential property
REMEDIATION

- **Short Term**
  - Removal of wastes from rear of residential premises
  - Construction of low permeability barrier
  - Ongoing Monitoring

- **Long Term**
  - Rehabilitation of landfill
  - Gas collection, venting, flaring
Landfill wastes being excavated from rear of residential properties
Proximity of properties to landfill wastes
CONCLUSIONS

- Important to establish adequate planning processes to identify and manage environmental hazards from landfills such as methane prior to redevelopment
- Use the right investigation techniques to identify hazards
- Be aware of sites that could potentially produce methane through changes to the environment during redevelopment
- Methane hazards adjacent to landfills can be managed (barriers, venting, flaring, collection)